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an output optical fiber;

an optical tap disposed between the input optical fiber and the output optical fiber and configured to couple a portion of at least some of the plurality of wavelength-division-multiplexed optical signals to

an optical spectrometer having a nominal resolution less than or equal to 8 Angstroms and a thermal stability of less than 50 parts per million per degree Centigrade of ambient temperature change and including

a linear variable filter with at least one tapered spacer region being tapered along a taper direction, and

a detector array affixed to the linear variable filter; and

an analyzer coupled to the optical spectrometer component so as to monitor each of the some of the plurality of optical signals.

Sub B1 cont.

A12 cont.

31. The optical transmission network of claim 30 wherein the optical spectrometer further comprises an analog-to-digital converter to provide digital electronic signals to the analyzer.

REMARKS

The undersigned hereby affirms the election of the Group I claims (claim 1-16 and 26) without traverse, and that claims 17-25 are withdrawn from consideration with specific reservation to pursue claims 17-25 in a division application. Inventorship remains unchanged. Claims 1-16 and 26 stand rejected, claims 17-25 are cancelled, and claims 27-31 are added, hence claims 1-16 and 26-31 are pending.

Claim 1 has been amended. Support for this amendment is found in the written description on page 5, lines 1-7, and in Fig. 1A. The undersigned believes this amendment does not add new matter. Support for new claim 27 is found in the Specification at least on page 11, and in as-filed claims 1 and 6. Support for new claims 28 and 29 is found in the Specification at least on page 12. Support for new claim 30 is found in the Specification at least on pages 8 and 11, and support for new claim 31 is found at least on page 10. The undersigned believes these new claims do not add new matter.

The Examiner has objected to the specification relating to the terms "picometers" and "parts-per-million", and their respective abbreviations. The undersigned brought this issue up with Dr. Robert Klinger, who is employed by the Assignee of this patent application, skilled in

the art of optical components, and familiar with the manner in which optical components are specified. Dr. Klinger explained that both picometers(pm)/°C and parts-per-million (ppm)/°C are commonly used to describe the stability of optical filters and similar devices. In the prior case, pm/°C describes thermal stability in terms of an absolute length (*i.e.* picometers) of wavelength shift, such as the shift in center wavelength of a bandpass filter, as a function of temperature change. Thus one can determine if how far the center wavelength will drift over a given temperature range.

Dr. Klinger also explained that thermal stability of an optical filter or similar device can be defined in relative terms as ppm/°C, similar to how a coefficient of linear expansion is defined. In other words, an optical filter with a longer center wavelength would exhibit a greater wavelength shift (in picometers) than an optical filter having a shorter center wavelength if both filters have the same thermal stability described as ppm/°C. Thus, if one knows the center wavelength, one can calculate the how far the center wavelength will drift over a given temperature range. One does not need to know the center wavelength to determine temperature drift if thermal stability is described as pm/°C.

In the case of line 18, page 8, the applicants merely translated one common convention to another common convention at a typical wavelength. In other words, the available optical filters have thermal stabilities of about 1-3 ppm/°C, which corresponds to about 0.001 nm/°C at the 1550 nm, thus illustrating the relationship between the two conventions that are both commonly used to specify thermal stability of optical filters. Accordingly, it is the Applicants' position that the Written Description is correct as it stands and respectfully request withdrawal of this objection.

The Examiner similarly objects to claims 6-8, 11, and 14 for similar reasons. The Applicants affirm that the proper unit in claims 6-8, 11, and 14 is parts-per-million, as supported on page 11, lines 13-22 of the Written Description. The applicants respectfully request withdrawal of these objections and sincerely apologize for any effect this issue might have had on the examination of the claims.

<u>Rejections Under 35 U.S.C. § 103</u>

Claim 1 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,343,542 by Kash et al. (hereinafter "Kash") in light of U.S. Patent No. 5,144,498 by Vincent (hereinafter "Vincent"). The Examiner cites Kash for disclosing all of the recited

elements of claim 1 except collimating optics, cites Vincent for disclosing collimating optics, and asserts that it would have been obvious at the time the invention was made to modify the device disclosed in Kash to include collimating optics. The Examiner further asserts collimating optics would have to be mated with collimating optics in almost any application, that the waveguide disclosed in Kash serves the function of collecting the divergent light rays from the optical fiber tip and illuminating the entire etalon structure along the taper direction, and that collimation optics would perform the same function. The Applicants respectfully traverse the Examiner's position.

The Examiner acknowledges that Vincent does not have a fiber optic input and asserts that one of skill in the art would appreciate that a divergent light source, such as a fiber optic tip, would have to be mated with collimating optics in almost any application. However, Kash does not use collimating optics between the optic fiber **101** and input waveguide **111** and the light from the fiber does not evenly illuminate the detector. Quite the contrary, light "leaks" out of one waveguide into another, and considerable amounts of light are extracted along the coupling length (Col. 11, lines 40-48). The optical demultiplexer apparently relies on the oblique propagation of light down the waveguides for its principle of operation (Col. 7, line 52- Col. 8, line 4), and teaches away from needing to mate collimating optics with the fiber end, both by the principle of operation of the device, and by the fact that Kash couples light from the fiber end directly to the input waveguide without collimating optics.

Claim 1, as amended, recites, among other elements, that the collimating optics are disposed between a fiber optic input and a linear variable filter to illuminate the linear variable filter with a collimated light beam. A standard dictionary definition of "collimate" is "to make parallel; line up" (*The American Heritage Dictionary*, Houghton Mifflin Co. (1975)). As illustrated in Fig. 1A and described on page 5, lines 1-7 of the application, the light from the optic fiber end is expanded into a collimated light beam that illuminates the linear variable filter **12** with parallel light rays **7, 9**.

Kash states that the resonator in the optical demultiplexer is operated at oblique incidence, and distinguishes its operation from Fabry-Perot cavities operated at normal incidence (Col. 7, lines 44-60). The optical demultiplexer of Kash couples light from the input waveguide **111** to the resonant Fabry-Perot cavity **301** (Col. 5, lines 19-24) when the propagation constants of the two waveguides match (Col. 5, lines 66-68). Accordingly, the Applicants respectfully traverse the Examiner's position that the input waveguide disclosed in Kash serves the same

function as collimation optics. In particular, the input waveguide does not expand the light from the end of the optic fiber into a collimated (*i.e.* parallel) light beam.

Kash discloses an optical demultiplexer that is complete and functional. The optical demultiplexer does not have collimation optics, does not need collimation optics, and to modify the device so that the tapered waveguide is illuminated with a collimated light beam would fundamentally alter the operation of the device. Therefore, the Applicants believe Kash does not suggest claim 1 in combination with any reference, and that claim 1 and all claims that depend from claim 1 are allowable.

Claim 3 stands rejected as being obvious over Kash and Vincent in further view of the technical paper entitled *Temperature Stability of Thin-Film Narrow-Bandpass Filters Produced by Ion-Assisted Deposition* by Haruo Takashashi (hereinafter "Takashashi"). Claim 3, which depends from claim 1, recites that the taper region comprises SiO_2. The Examiner states that Kash's tapered etalon structure has a tapered spacer region of SiO_2. The Applicants respectfully traverse the Examiner's position. Kash discloses that the input waveguide **111** is very different from the resonator waveguide **301**, and that the resonator waveguide is composed of material with much higher index of refraction than the core of the input waveguide (Col. 5, lines 61-66). In a particular example, the input waveguide was made of SiO_2, but the resonator waveguide was made of the compound semiconductor AlGaAs to obtain a large difference of refractive index between the waveguides (Col. 11, lines 5-11). Kash teaches away from using SiO_2, or any other low-index material, for the resonator waveguide, because Kash discloses that a high-index material is desirable for the tapered resonator (Col. 7, line 64 - Col. 8, line 4). Therefore, the Applicants believe claim 3 is further patentable.

Claims 6-8, which depend from claim 1, stand rejected as being obvious in light of Kash, Vincent, and Takashashi. Each of these claims refers to thermal stabilities of less than 50, 25, and 10 parts per million per degree Centigrade of ambient temperature change, respectively. The Examiner acknowledges that Kash does not make reference to thermal stability, and cites Takashashi for disclosing a single-cavity etalon bandpass filter with a thermal stability of 5 picometers/°C at a center wavelength of 1540 nm. The Examiner then asserts that it would have been obvious to one or ordinary skill in the art to have made such a structure with thermal stabilities less than 10 picometers/°C. The Applicants respectfully traverse the Examiner's position.

In order to maintain this rejection, a reasonable expectation of success is required. No basis for an expectation of success has been provided. As discussed above in support of claim 3, Kash discloses using a compound semiconductor for the tapered spacer material of the resonator waveguide to obtain a high difference in refractive index between the input waveguide and the resonator waveguide. Light having a particular wavelength couples from the input waveguide to the tapered resonator waveguide depending on where the propagation constants of the two waveguides match for that wavelength (Col. 5, line 66- Col. 6, line 8; and Col. 8, line 5- Col. 9, line 35).

The Applicants believe that the location along the tapered resonator where a particular wavelength will couple from the input waveguide to the tapered resonator will vary with temperature due to the relative changes in propagation characteristics of the waveguides resulting from the different materials that are used to obtain the inter-waveguide coupling. There is no suggestion that the structure disclosed in Kash could obtain the recited thermal stabilities, any reasonable expectation of success if the structure were modified according to the disclosure of Takashashi, and no enablement in any combination of the cited references to achieve the recited thermal stabilities with the structure disclosed in Kash. Furthermore, Takashashi obtains stable filters using ion-assisted deposition of specific materials, while Kash used MOCVD to deposit the compound semiconductor material of the tapered resonator waveguide. The Examiner has not provided a convincing line of reasoning to support that the ion-assisted deposition techniques disclosed in Takashashi could be adapted to the materials used in the device of Kash. Therefore, the Applicants believe claims 6-8 are further allowable.

Claim 10, which depends from claim 1, recites that the linear variable filter is a band-edge filter. The Examiner asserts that a band edge filter is considered equivalent to a bandpass filter. The Applicants respectfully traverse the Examiner's position. While Vincent discloses using serial band-edge filters to obtain narrow bands of transmitted or reflected light along the length of the serial filters (Col. 17, lines 29-52; Figs. 8A-8B), these filters operate to produce a narrow band of reflected or transmitted light, and not as a band-edge filter. The undersigned emphasizes that the band-edge filter recited in claim 10 is not used in series with a complementary band-edge filter to obtain a narrow passband, but that a variable band-edge response is obtained from the recited filter and provided to the detector array. As discussed on page 11, lines 30-32 of the application, the Applicants initially believed that a narrow passband

filter was necessary to build an optical spectrometer, but realized that a variable edge filter could be used as well.

The Applicants explain the differences between using a bandpass filter and a band edge filter on page 12, lines 1-21. The steep, sharp transition attainable with band edge filters allows measuring and monitoring of closely-spaced optical signals when used with an inverse transfer reconstruction technique (page 13, lines 27-32), or when the there is limited noise or limited dynamic range of the signal (page 12, lines 17-18), for example. Therefore, the Applicants believe claim 10 is further allowable.

Claim 11 recites, among other elements, a fiber optic input, a collimating lens, and a linear variable filter having a thermal stability of less than or equal to 50 parts per million per degree Centigrade of ambient temperature change. Thus the Applicants believe claim 11 is allowable for at least the reasons given above in support of claims 1 and 6. The undersigned further directs the Examiner's attention to page 11, lines 4-12, and 23-30, wherein the Applicants explain that the recited thermal stability enables use of a high-resolution optical spectrometer for a reasonable period of time without re-calibrating the device. This solves the long-standing problem of obtaining high-resolution optical spectrometry without frequent re-calibration. The Applicants respectfully request reconsideration of claim 11 and removal of its rejection.

Claim 12, which depends from claim 11, recites an optical detector array less than 12 mm long along the taper direction of the linear variable bandpass filter. Although the Examiner states than none of the references disclose a specific length of a detector array, the undersigned respectfully directs the Examiner to Col. 12, line 22 of Kash, which discloses a 4.5 cm chip, which is nearly four times as large as the optical detector array recited in claim 12. It appears that such a large device is needed to obtain the required coupling between waveguides (Col. 12, lines 4-5), and that one is not free to arbitrarily shorten the taper length and increase the taper angle of Kash, as implied by the Examiner. Accordingly, no enablement of the claimed invention appears in the cited references, and no expectation of success is apparent in the proposed modification of the optical demultiplexer of Kash.

It is further noted that the specification enables a spectral range of 1530-1570 nm over a 12 mm tapered spacer. A 12 mm detector array with 256 elements on nominally 50 micron centers and an 80% fill factor provides a detector spectral range of about 0.13 nm (*See*, Specification, page 5, lines 22-32). The full width half maximum ("FWHM") of the peaks shown in Fig. 4 of Kash are between 100-250 microns (Col. 11, line 62- Col. 12, line 7). Thus

the present invention provides superior resolution in a smaller optical structure and the Applicants believe claim 12 is further patentable.

Claim 13, which depends from claim 11, recites a linear variable bandpass filter with a 50% bandwidth of less than or equal to 0.6 nm at a center wavelength between about 1530-1600 nm. In comparison, Vincent discloses double-cavity filters with an FWHM of 11.2 nm at a much shorter center wavelength of 669 nm (Col. 13, lines 55-57). The Examiner cites Takashashi for disclosing a narrow bandpass filter with a FWHM of 0.5 nm at 1540 nm. However, Takashashi does not disclose or suggest a linear variable filter with such a bandwidth, much less using such a filter in an optical spectrometer in combination with the other recited elements. As explained in the Specification, page 11, lines 13-22, the Applicants did not initially pursue a linear-filter based optical spectrometer having these characteristics because they believed that such an optical spectrometer could not achieve resolution better than 8 Angstroms. It was only after realizing that a <u>suitably stable</u> linearly variable filter that is truly continuous could be fabricated that the inventors attempted to build such an optical spectrometer. The stability of the linear variable bandpass filter works in conjunction with the narrow bandwidth at the recited wavelengths to enable the desirable device recited in claim 13.

The multiplicity of references cited by the Examiner do not contain any suggestion that they be combined to result in the invention of claim 13. Each reference is individually complete, and no reference or combination of references teaches the desirability of the claimed invention, or enables the results obtained by the claimed invention. The surprisingly desirable results obtained by the Applicants support the conclusion that claim 13 is not obvious. The Applicants respectfully request reconsideration of claim 13 and removal of this rejection.

The Applicants believe claim 14 is allowable for at least the reasons provided above in support of claims 1, 6, 12, and 13. Even if the disclosures of Kash, Vincent, and Takashashi were combined they would not result in the present invention because there is no disclosure of a linear variable bandpass filter having the combination of characteristics recited in claim 14. Thus, all elements of the claim are not found in the cited references. Reconsideration of claim 14 and removal of its rejection is respectfully requested.

Claim 26 recites, among other elements, an optical transmission network comprising an optical input fiber carrying wavelength-division-multiplexed (WDM) optical signals having nominal channel spacing of 200 GHz to an optical tap that couples at least some of the WDM signals to a linear-variable-filter-based optical spectrometer. The Examiner cites Kash for

disclosing the structure of an optical fiber input, a linear variable filter, and a detector array, but not the periphery network and analyzer. The Examiner cites Vincent for disclosing using a computer to analyze the output from the etalon, and asserts that one would have to insert an optical tap, such as a beam splitter, into an optical network to sample the signals without removing them from the line or significantly attenuating the signals.

A channel spacing of 200 GHz corresponds to a wavelength separation of about 1.6 nm at a nominal center wavelength of 1550 nm (*See*, Specification, page 1, lines 31-32). As the Examiner notes on page 9 of the Office action, the spectrometer resolution should be better than the FWHM of the signals being resolved; thus, the spectrometer should have a resolution less than 1.6 nm. The Applicants have enabled optical spectrometers with a nominal resolution of 8 Angstroms or less (Page 3, line 34). The optical demultiplexer disclosed in Kash does not appear to achieve this resolution at the recited wavelengths, and thus is not an enabling reference upon which this rejection can be maintained. Furthermore, it is unlikely that the optical demultiplexer of Kash could be modified to achieve such resolution in a practical application because of the thermal stability issues arising from the use of different materials in the input and resonator waveguides. Therefore the Applicants believe claim 26 is allowable and respectfully request reconsideration and withdrawal of this rejection.

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Version of Amended Text Showing the Changes Made

The following marked-up claim shows the changes made to arrive at the substitute claim shown above:

1. [AMENDED] An optical spectrometer component comprising:

a fiber optic input;

collimating optics; **[disposed between the fiber optic input and]**

a linear variable filter having

an etalon structure with

a tapered spacer region being tapered along a taper direction**[, the linear variable filter being affixed to]** ; and

a linear optical detector array disposed along the taper direction, the collimating optics being disposed between the fiber optic input and the linear variable filter to illuminate the linear variable filter with a collimated light beam, wherein the linear variable filter is affixed to the linear optical detector array.

Conclusion

In view of the foregoing, the Applicants believe all claims pending in this Application are in condition for allowance, and that the Applicants are entitled to the claims in accordance with the Title 35 of the United States Code and Art.1, §8, cl.8 of the Constitution of the United States. The Applicant respectfully request reconsideration of all pending claims, the withdrawal of all rejections, and the issuance of a formal Notice of Allowance at an early date.

If the Examiner believes this amendment does not put all pending claims in condition for allowance, the undersigned invites the Examiner to telephone the undersigned at (707) 591-0789.

Respectfully submitted,

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